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(54) A torque limiting clutch for a power tool

(57) The clutch has a driven member (14, 17) with a series of interconnected camming surfaces, and the driving member (13) carries clutch balls (18) in radial passages, each ball (18) being biassed against a respective camming surface by spring-loaded sleeve (19). As shown, the clutch is embodied in a pneumatic screwdriver and the camming surfaces have detent recesses (33) or ears whereby a greater torque is transmitted in one direction than the other. A push rod (29) for actuating a valve controlling the air supply to the screwdriver opens the valve upon application of thrust sufficient to compress spring (27) and is released to close the valve when latch sleeve (23) is shifted against spring (37) by sleeve (19) in response to clutch slip.

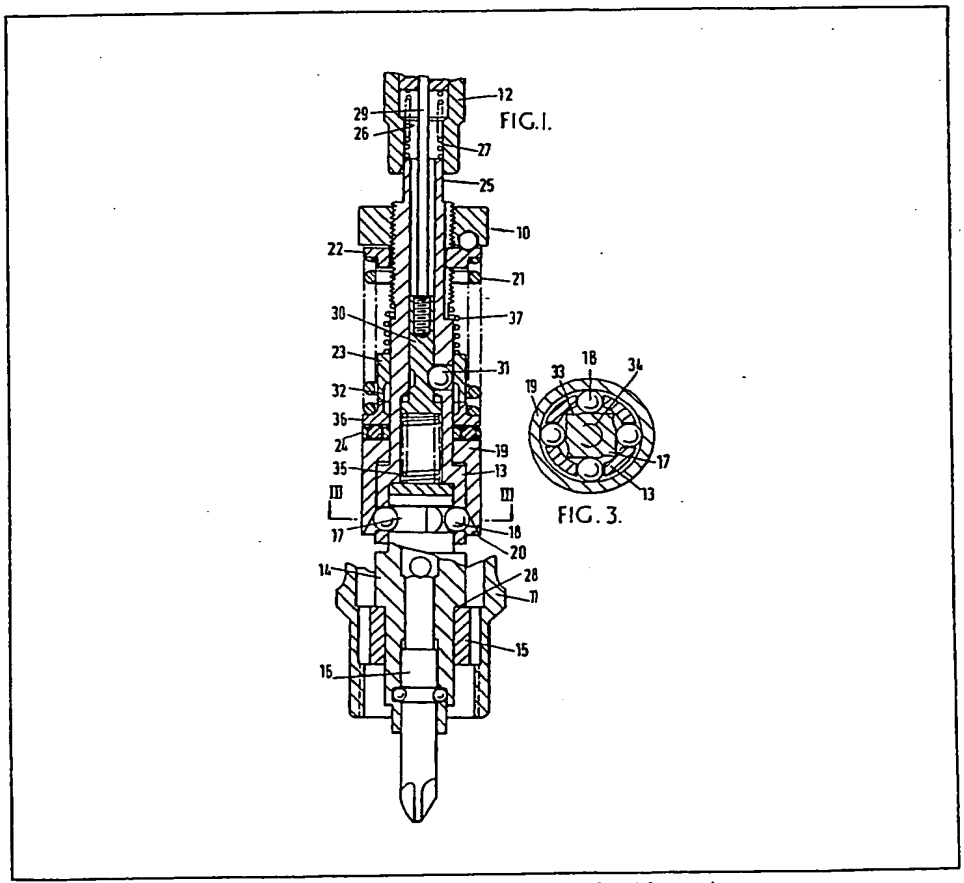

FIG. 1.

FIG. 3.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

FIG. 1.

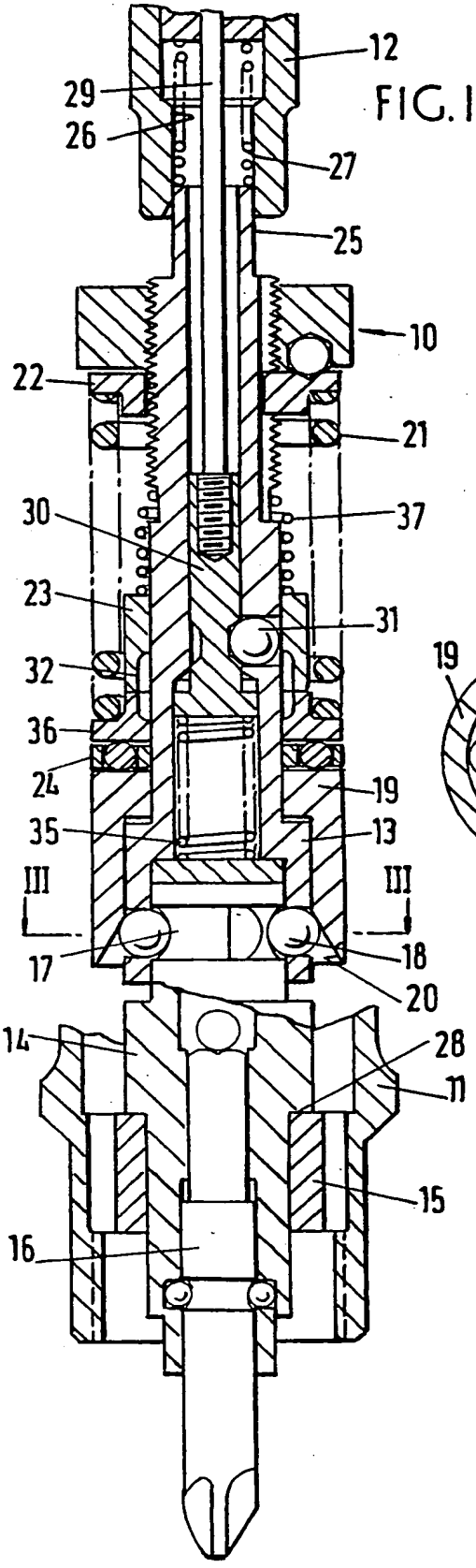
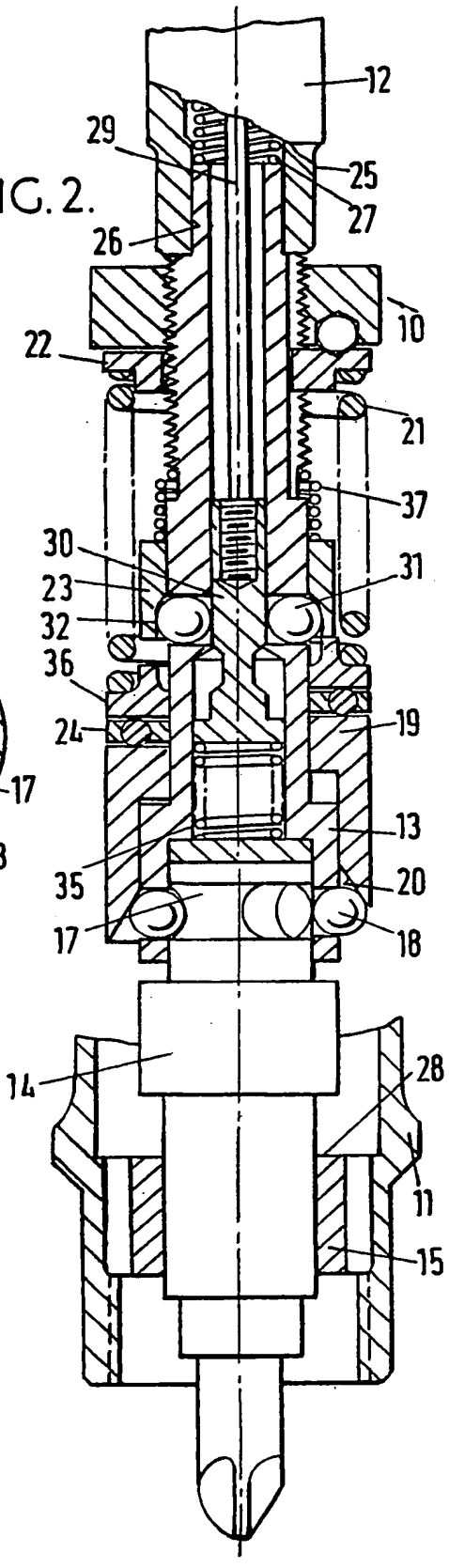


FIG. 2.



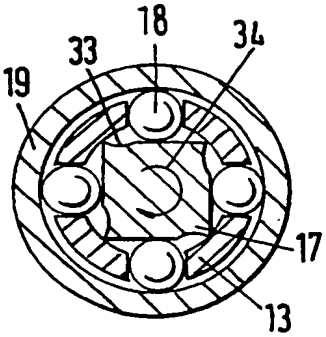


FIG. 3.

SPECIFICATION

A clutch for a power tool

This invention relates to a clutch for a power tool, of the type which can transmit rotation in both directions.

Clutches of this type are used for tightening small fasteners to very low torques. For example, the fasteners may be screws driven by a screwdriver. The torques will generally be below 10 lbs. ins. The tool can be used for both hard and soft joints.

In the prior art clutches, the driven member, i.e. the part of the clutch to which the tool, e.g. a screwdriver bit, is fixed, is of substantial mass and, therefore, it has a relatively high inertia which can continue to tighten the fastener, e.g. a screw, after the clutch has disengaged.

In accordance with the present invention, there is provided a clutch for a power tool, the clutch having coaxial driving and driven members, the driven member comprising a series of interconnected camming surfaces and the driving member including a plurality of clutch balls arranged in radial passages around the axis of the clutch, each ball being biased against a respective camming surface by means which can yield when a torque above a predetermined value is transmitted across the clutch to allow the balls to move away from the clutch axis so that the driving member can rotate relative to the camming surfaces on the driven member.

It is thus possible to provide a clutch having a driven member of lower inertia than the driving member.

Preferably, the axes of the radial passages intersect the axis of the driven member and the camming surfaces are so shaped that a greater force is needed for the balls to reach the ends of the camming surfaces in one direction of rotation than in an opposite direction of rotation.

Thus, a greater torque can be exerted in said one direction than in the opposite direction so that a screw or other fastener tightened up to a predetermined torque by rotation in said oppoiste direction can be removed by the greater torque available by rotation in said one direction.

Preferably, means are provided to cut-off power to the driving member in response to said movement of the balls away from the clutch axis and, conveniently, the power cut-off means are operable to stop the tool just before the balls reach the ends of the camming surfaces.

Preferably, the interconnected camming surfaces are faces of a substantially regular polygonal boss on the driven member, and each face has a detent recess or a projecting ear at or adjacent to one edge of the face.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawing, in which:

Figure 1 is a longitudinal section through part of a power tool which includes one embodiment of a clutch according to the invention and illustrated in a datum position;

Figure 2 is a part longitudinal section which on the right hand shows the clutch of Figure 1 in a cut-off position and which on the left hand side shows the clutch of Figure 1 in a position prior to reset; and

Figure 3 is a cross-section through Figure 1 on the lines II-II.

Referring to the drawing, there is shown therein a power tool 10, in the form of a screwdriver, which is intended to be driven by an air motor (not shown). The tool 10 has a tubular casing 11 which contains the motor (not shown) drivingly connected to a shaft 12 *via* a gear box (not shown). A clutch has a driving member 13, which is connected to the shaft 12 so as to be rotated therewith, and a driven member 14, the forward portion of which is mounted in a bearing sleeve 15 fixed in one end of the casing 11 and is adapted to releasably locate a screwdriver bit 16. One clutch member is constituted by a boss 17 at the rear end of the driven member 14 and the other clutch member by balls 18 carried in radial passages formed in the forward end of the driving member 13. The balls are biassed by means of a spring-loaded sleeve 19 mounted on the driving member 13 and having a frusto-conical end surface 20 which engages the balls. Compression spring 21 pushes the sleeve 19 over the balls and the end surface 20 pushes them in towards the axis of the clutch.

The end of the compression spring 21 remote from the sleeve 19 abuts against an annular block 22 keyed to the driving member 13 in such a manner that its position along the axis of the driving member 13 can be adjusted in order to vary the compression in the spring 21. The other end of the spring 21 abuts against an outwardly extending flange of collar 36 which is mounted on the driving member so as to be axially slidable therealong. A latch sleeve 23 is also mounted on the driving member 13 so as to be axially slidable therealong and is biased towards the rear end of the collar 36 by a compression spring 37. A thrust bearing 24 is interposed between the collar 36 and the sleeve 19 so that the sleeve 19 can rotate freely relative to the spring 21 which is under compression and which engages the block 22 keyed as aforesaid to the driving member 13. The sleeve 19 is also free to rotate about the driving member 13 so that as the balls 18 are cammed outwards as hereinafter more fully explained, they will rotate about axes parallel with the tool axis so that there is no sliding between the ball surface and either of the surfaces with which the balls are in contact.

The driving member 13 has at its rear end a tubular boss of non-circular cross-section which extends into a correspondingly shaped recess 26 in the forward end of the shaft 12. The shaft 12 is fixed against axial movement relative to the casing 11 and a compression spring 27 mounted in the recess 26 urges the driving and driven members 13 and 14 respectively forwards until a shoulder 28 on the driven member 14 engages the bearing sleeve 15 (see Figure 1). A push rod 29, which operates an air valve for the motor, extends through the shaft 12 and into the driving member 13 where it engages a latch bolt 30. The driving member 13 has radial passages which accommodate balls 31. The balls 31 normally project into an annular recess in a latch bolt 30 where they are retained by the latch sleeve 23, but

the sleeve 23 and collar 36 define an annular groove 32 which when aligned with the passages accommodating the balls 31 (see Figure 2) as hereinafter described allows the balls 31 to move radially away from the axis of the driving member 13.

The particular cross-sectional shape of the boss 17 is shown in Figure 3. As will be seen, this is of generally square cross-section but each face has a detent recess adjacent to the trailing edge of the face when viewed in the direction of forward rotation of the boss 17 indicated by arrow 34 in Figure 3. The purpose of these detent recesses 33 will be explained hereinafter.

In operation, the screwdriver bit 16 is located in the head of the screw and sufficient thrust is applied to compress the spring 27. The push rod 29 moves rearwardly and this acts on a start valve (not shown) which will supply power to the motor. The torque is transmitted from the shaft 12 through the driving member 13 and the balls 18 to the driven member 14 and the screwdriver bit 16. During rotation below a predetermined torque, the balls 18 grip the boss 17, and the driving and driven members 13 and 14 respectively rotate in unison with the balls remaining in the position shown in Figure 3.

When the maximum torque is approached, the load retards the driven member 14 and the boss 17 turns slightly slower than the driving member 13. As a result, the balls 18 begin to roll along the r spective camming surface of the boss and are cammed outwards against the force exerted by the sleeve 19. As this takes place, the sleeve is moved axially against the spring 21 and spring 37. When the maximum torque is reached, all the balls 18 are just before that edge of their camming surface remote from the respective detent recess 33 and the groove 32 defined by the latch sleeve 23 and collar 36 is aligned with the radial passages accommodating the balls 31 (see Figure 2 right hand side). Thus, the balls 31 are allowed to move radially away from the axis of the driving member and such movement releases the latch bolt 30 which will move axially forward and hence allow the start valve to thereby cut-off air supply to the motor. Due to the influence of any stored energy in the motor and gearbox, the driving member 13 will continue to rotate and the balls 18 will pass over the edge of the cam surfaces on the boss 17.

Thrust on the screwdriver bit 16 is then relaxed, thus allowing the driven member 14 to datum on on shoulder 28 due to the influence of spring 27 and then latch sleeve 23 moves forward under the influence of spring 37, while the latch bolt 30 is held in contact with the push rod 29 due to a spring 35.

On reverse rotation, the situation is similar except that the balls 18 will move along the respective camming surface and into a detent recess 33 of the boss as the predetermined torque is approached. These recesses lock onto the balls 18 and hence a greater force has to be applied to the balls before they run over the edges of the camming surfaces (adjacent to these recesses 33) than was the case of rotation in the forward direction. In practice, the reverse rotation is used to remove a screw and a sleeve 19 will not be moved enough to release the air valve and the balls will not run over the edges of the camming surfaces, because sufficient torque should be available to start the screw moving before this stage is reached.

As aforesaid, the position of the block 22 can be adjusted along the axis of the driving member 13 in order to vary the compression in the spring. By this means, the torque at which the sleeve 13 will move to operate the air valve can be varied.

In an alternative embodiment (not shown) each detent recess may be replaced with an ear which presents a more steeply inclined camming surface (i.e. a surface with a greater approach angle) to the balls than the remainder of the camming surface. Therefore, once again the balls 18 will need to have a greater force applied to them to overcome this steeper slope when the tool is operated in a reverse direction.

CLAIMS

1. A clutch for a power tool, the clutch having coaxial driving and driven members, the driven member comprising a series of interconnected camming surfaces and the driving member including a plurality of clutch balls arranged in radial passages around the axis of the clutch, each ball being biassed against a respective camming surface by means which can yield when a torque above a predetermined value is transmitted across the clutch to allow the balls to move away from the clutch axis so that the driving member can rotate relative to the camming surfaces on the driven member.

2. A clutch as claimed in claim 1, wherein the axes of the radial passages intersect the axis of the driven member and the camming surfaces are so shaped that a greater force is needed for the balls to reach the ends of the camming surfaces in one direction of rotation than in an opposite direction of rotation.

3. A clutch as claimed in claim 1 or claim 2, wherein means are provided to cut-off power to the driving member in response to said movement of the balls away from the clutch axis.

4. A clutch as claimed in claim 3 wherein the power cut-off means are operable to stop the tool just before the balls reach the ends of the camming surfaces.

5. A clutch as claimed in any one of the preceding claims, wherein the interconnected camming surfaces are faces of a substantially regular polygonal boss on the driven member.

6. A clutch as claimed in claim 5 when dependent on claim 2, wherein each face has a detent recess at or adjacent to on edge of the face.

7. A clutch as claimed in 5 when dependent on claim 2, wherein ach face has a projecting ear at or adjacent to one edge of the face.

8. A clutch for a power tool substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

9. A power tool including a clutch as claimed in any one of the preceding claims.

10. A power tool as claimed in claim 9, in the form of a power screwdriver.

11. A power tool as claimed in claim 9 or claim 10, comprising an air motor for driving the driving member of the clutch.

New claims or amendments to claims filed on 8.10.80
Superseded claims 1-11
New or amended claims:-

1. A clutch for a power tool, the clutch having coaxial driving and driven members, the driven member comprising a series of interconnected camming surfaces and the driving member including a plurality of clutch balls arranged in radial passages around the axis of the clutch, each ball being biassed against a respective camming surface by means which can yield when a torque above a predetermined value is transmitted across the clutch to allow the balls to move away from the clutch axis so that the driving member can rotate relative to the camming surfaces on the driven member, means being provided to cut off power to the driving member in response to said movement of the balls away from the clutch axis.

2. A clutch as claimed in claim 1, wherein the axes of the radial passages intersect the axis of the driven member and the camming surfaces are so shaped that a greater force is needed for the balls to reach the ends of the camming surfaces in one direction of rotation than in an opposite direction of rotation.

3. A clutch as claimed in claim 1 or claim 2, wherein the power cut-off means are operable to cut-off power to the driving member just before the balls reach the ends of the camming surfaces.

4. A clutch as claimed in any one of the preceding claims, wherein the interconnected camming surfaces are faces of a substantially regular polygonal boss on the driven member.

5. A clutch as claimed in claim 4 when dependent on claim 2, wherein each face has a detent recess at or adjacent to one edge of the face.

6. A clutch as claimed in claim 4 when dependent on claim 2, wherein each face has a projecting ear at or adjacent to one edge of the face.

7. A clutch for a power tool substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

8. A power tool including a clutch as claimed in any one of the preceding claims.

9. A power tool as claimed in claim 8, in the form of a power screwdriver.

10. A power tool as claimed in claim 8 or claim 9, comprising an air motor for driving the driving member of the clutch.

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